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ABSTRACT

This paper examines hypermedia design and draws conclusions about how educational research and theory applies to various aspects of World Wide Web (WWW) homepage design. "Hypermedia" is defined as any collection of information which may be textual, graphical, visual, or auditory in nature and which may be accessed via a nonlinear route. The paper covers hypermedia background and terminology, screen design, information structure, navigation, the impact of hypermedia design on exploration and learning, design issues specific to WWW homepages, and applying hypermedia research and theory to WWW homepage design. Recommendations for WWW homepage design include: (1) keep screen design consistent; (2) use text that is at least 12 point; (3) utilize layering capabilities to keep text in small consistent segments; (4) develop medium density screens and moderately complex screens; (5) concentrate items at the screen's optical center; (6) mix high and low color intensity or brightness to focus user attention; (7) with graphics, use wrap-around text rather than run-around text; (8) develop structure through use of headings, bold type, and white space; (9) map the structure of information; (10) each node/destination should be able to stand alone; (11) incorporate appropriate metaphor; (12) provide visual clues indicating users' selections are being processed; (13) include graphic or text-based organizers; (14) include comparative, causal, sequential, associative, exemplary, and componential links; (15) employ labeled and unlabeled links; and (16) when designing complex WWW homepages, consider using multiple complementary stimuli. (Contains 43 references.) (SWC)

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WORLD WIDE WEB HOMEPAGE DESIGN

Michael L. Tillman

The intent of this paper is to draw some conclusions about what educational research and theory have to say about various aspects of World Wide Web (WWW) homepage design. Since there is very little research and theory related to WWW homepage design at this point and time, I will focus on research and theory related to hypermedia design, the vast majority of which is directly applicable to WWW homepage design. I will use the term hypermedia to encompass hypertext and hypermedia. As used in this paper hypermedia will simply mean any collection of information which may be textual, graphical, visual or auditory in nature and which may be accessed via a nonlinear route.

Initially, I will cover hypermedia background information: history, definitions, etc. and elements of screen design such as density and layout. Then I will concentrate on the structure of information and navigation. The information structure section will include node and database design and the use of graphical organizers. Issues covered in the navigation section will include specific versus nonspecific link types and disorientation. I will discuss the impact of hypermedia design on exploration, recall and learning. Finally, I will emphasize some design issues that are specific to a particular hypermedia application: WWW homepages and attempt to apply hypermedia research and theory to WWW hompage design.

HYPERMEDIA BACKGROUND AND TERMINOLOGY

Vannevar Bush, President Franklin Roosevelt's science advisor, is credited with being the original conceiver of what is now called hypermedia. He believed the brain operated by association so he developed the Memex to model that process. The Memex, as conceived of by Bush, allowed for the associative interconnection of large amounts of information that had been microfiched. Eventually Ted Nelson refined the idea with Zanadu a literature based project. He is also credited with coining the term hypertext which eventually evolved into the term hypermedia.

Within the literature there is not a consistently excepted definition of hypertext or hypermedia. Sweeters (1994) sees hypertext as a collection of information that includes "hot spots" that when activated branch the user to additional related information. He believes hypermedia to be a combination of hypertext and full motion video. Halasz (1989) considers hypermedia to be an information representation and management system built around a network of nodes connected by links. Because of the enormous improvement of graphic capabilities since the inception of the term "hypertext" Tohurst (1995) believes the term hypermedia has become commonly used. She thinks both terms include multiple media presentation linked in a nonlinear format. However, according to her, hypertext includes only static media while hypermedia may include static and dynamic media.

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In many instances hypertext and hypermedia definitions overlap each other. Locatis, Letourneau and Banvard (1989) state hypermedia has become an umbrella term for knowledge bases having any type of information in the form of nodes that can be accessed in a nonlinear fashion via links. Moore (1994) believes the terms are interchangeable as used in much of the literature and that hypermedia is a prolongation or hypertext facilitated by technological advances. As I have stated in the introduction, I will use the term hypermedia to encompass both hypertext and hypermedia.

For the remainder of this paper the term hypermedia will be defined as any collection of information which may be textual, graphical, visual or auditory in nature and which may be accessed via a nonlinear route. Gail and Hannafin (1994) devised a framework for examining hypermedia that includes definitions for several component parts of a hypermedia system. They mention interface: the mechanism through which users interact with the hypermedia system, nodes: units of information or hypermedia destinations, links: connections between nodes, and navigation: user movement through a hypermedia system. Additional related definitions will be covered in the information structure and navigation sections of this paper.

SCREEN DESIGN

Screen design is perhaps the most easily understood aspect of hypermedia design. As much as possible, one should strive for consistency. Marchionini (1991) believes screen design should be consistent in order to compensate for cognitive limitations. He thinks the interface should be as transparent as possible so that available cognitive resources are utilized for the task at hand rather than interface interpretation. Heines (1984) recommended that there should be specific areas on the screen where certain types of information could always be found. Universal icon meaning and positioning are also important aspects of screen design consistency. However, one must realize that dynamic programs with overlapping windows and presentation areas that require the user to manipulate information on the screen make it ever more difficult to maintain consistency with regards to screen design (Jones, 1995).

The first specific aspect one needs to consider is text appearance and density. Ten point text is not adequate (Boing, 1994) and many twelve or fourteen point text are not easy to read on a computer screen. Jonassen (1982) found that reading speed and comprehension where about the same for justified and unjustified text. Faiola and Debloois's (1988) research revealed that breaking large portions of text into smaller portions improves visual clarity and retention. Hypermedia's unique attributes facilitate this process through the utilization of its layering capabilities.

Morrison et al. (1989) conducted a study that investigated viewer preferences for various text density levels. They used realistic stimulus material and found that subjects indicated the highest preference for medium density screens while tending to select higher-density screens over lower-density screens. Viewers also preferred higher-density screens over lower-density screens when viewing only the first screen of each density level. The authors reached the conclusion that realistic materials may produce different results than nonrealistic materials because users judge the screen on contextual and aesthetic appeal. The realistic higher-density materials provide more contextual clues on a single frame and thus foster comprehension.

Text location, color, link display and run-around versus wrap around text are other issues related to screen design. Baird, Turnbell and McDonald theorized that an imaginary line just above the center of the screen marks what can be called the optical center: the point where the reader's vision will focus. One should therefore concentrate items at the optical center. A study completed by Aspillage (1991) found that placing text at the upper middle section of the screen facilitated learning at a greater level than placing the text on the screen at random positions.

Pett and Burbank (1991) reported color related research findings of relevance to hypermedia design. According to a survey of the literature they conducted a high-value (value equals color intensity) area on a low-value background or a low-value area on a high-value background or a high-chroma (chroma equals color brightness) area on a low-chroma background will attract attention more than difference in hue (color). Although some studies have shown that color, when used as a cue, does not, in general, increase learning other studies have shown that color may produce a more positive attitude, facilitate the focusing of attention, increase recognition memory and be more effective for search tasks then black and white.

Research on memory suggests that humans can hold on to just five to seven chunks of information at a time. The linking capabilities of hypermedia can serve to free up short term memory. However, when designing a WWW homepage one should strive to include only the amount of information and/or links that can be read from a single screen as many users will not scroll beyond the first screen (Falcigno & Green, 1995). If graphics are to be added to the mix one should keep in mind that wrap-around text with irregular borders that conform to the shape of the graphic leads to greater comprehension than run-around text which is text that is boxed around the graphic with straight borders (Nelson-Knupher & Stock-McIsaac 1991).

Much of the information in this section was drawn from research focused on the unique contribution of a particular text element. Grabinger (1989) raised an interesting point when he theorized the unique contribution of each text element to overall meaning is probably quite small. He believes users judge screens based on an overall hierarchy the includes structure, organization and spaciousness. If a screen is well structured it is designed in a way that reflects the content of the subject matter, uses directive clues for emphasis, includes headings and graphics that separate information into chunks and emphasizes the most important parts of the information. Structure is a refined state of organization. When sufficient structure is not present users look for organization. Screens that are organized appear to have a coherent arrangement of all major elements, but don't represent the nature of the content. If neither of the above are present they look for spaciousness and simplicity i.e. lots of white space, little text, few buttons, etc.

Grabinger (1993) conducted a study that measured viewers overall judgements of screen designs. He found that viewers preferred screens that were structured through the use of headings, provided directive cues via the use of bold type, had well defined functional areas, included multiple columns of text versus a single column, incorporated white space around the exterior of the screen margins and utilized spaced paragraphs rather than indented paragraphs. Viewers disliked screens that were crowded with plain text, used few graphics, appeared disorganized and/or included unbalanced presentations with large areas of white space. He reached the conclusion that viewers preferred screens that were moderately complex: clear but sophisticated enough to be visually interesting.

INFORMATION STRUCTURE

The nonsequential navigation capabilities of hypermedia provide many design opportunities and challenges related to information structure. According to Jonassen (1988) hypermedia is a node-link system based on semantic structures. This allows for the mapping of the structure of the knowledge the system is presenting/representing. The system may also be used to model an expert's knowledge structure. Jonassen believes parts of these structures may be mapped directly onto the learner's cognitive structure.

The most basic element of hypermedia information structure is the node. Nodes are individual bits of information. They might also be considered individual destinations. They should be able to stand alone. Locatis, Letourneau, and Banvard (1989) suggest design issues to be considered include size, number to display simultaneously and whether or not to display node types in order to make their content obvious to the user.

Another issue the designer must deal with is segmentation or the division of information. The designer must determine idea units and present them in internally consistent segments (Frase and Schwartz, 1979). If properly segmented, the information will facilitate initial decoding, subsequent encoding and retrieval. Chunking and granularity are terms with similar meanings. Particular information may have to be repeated in more than one successive segment so the reader won't have to go back to previous segments to figure out the meaning of the present segment.

Normally information will be structured to include a combination of embedded, explicit, hierarchical and associative links. Embedded links are words or phrases within the larger body of information. Explicit links are links that are arranged in the form of a list of possible choices. Koved and Sneiderman (1986) found that embedded links resulted in higher user satisfaction and more questions answered correctly. They believe the context might help the user make more efficient link choices. On the other hand, a study completed by Lai and Waugh (1994) determined that users favored explicit links. That same study also concluded that users prefer hierarchical rather than associative links.

Metacognition, the management of cognitive processes, is supported through the use of metaphors and closure. Jones and Okey (1995) believe hypermedia based information, if structured properly, facilitates the incorporation of metaphors and closure. Guidelines for providing efficient metaphors include making the metaphor obvious to the user and applicable to the information being presented. One should not use a forced or inappropriate metaphor.
Guidelines for providing effective closure consist of organizing information into manageable segments, providing users with information that lets them know they are making progress, and providing a sense of accomplishment via the use of a mechanism that indicates path history or visual clues that indicate progression.

Graphic organizers or schemata provide map like organizers that activate more then one memory system. Cooper-Shaw (1991) concluded that these devices facilitate the organization of knowledge and increase user perception of relationships that might not have been apparent in less visual representations of knowledge, which, in turn, probably leads to improved retention. If utilized, graphical browsers should be accessible from any point in the document.

Gall and Hannafin (1994) and Neuman (1993) developed overall frameworks for looking at certain aspects of hypermedia including information structure. Gall and Hannafin believe the knowledge base component of hypermedia can be described relatively in terms of breadth (the diversity of subject matter), depth (the amount and complexity of information on a given topic) and homogeneity (the degree of similarity-dissimilarity of data sources). Neuman developed issues that need to be examined when designing the informational content of a hypermedia document. She believes the designer must consider what types of information to include and how much information to include. They must also determine how the information should be rationed, ordered and highlighted in order to improve useability.

NAVIGATION

A third important component of hypermedia design, along with screen design and information structure, is navigation. Jones (1995) believes that since computer software is not used on a daily basis navigational qualities need to be almost self evident. Users must be able to explore the program for new information, know where they found it and be able to find it again. As already mentioned, links are connections between nodes. A user must traverse links in search of information (nodes). The literature provides a variety of ways to categorize links. Locatis, Letourneau, and Banvard (1989) categorize links as either organizational (links that facilitate the creation of a hierarchical structure) or referential (links that designate a semantic relationship). A study conducted by Harmon and Dinsmore (1994) investigated novice linking by students and found they created seven distinct types of links: comparative, causal, sequential, associative, exemplary, componential and accidental. They considered this to be a positive finding because of the number of link types that the subjects created without prompting. They believe the finding is an indication of the diverse goals hypermedia and multimedia systems can be designed to address. Incidently, the authors felt that comparative, associative, and causal links might build critical thinking skills.

After deciding what types of links to include a hypermedia designer must determine what level of link display to employ. One may choose to simply let the user know that a link exists without labeling it or they may label each link. A study conducted by Zhao, O'Shea and Fung (1994) indicated that labeling links with semantic relationships had a positive effect on learning. But, they weren't able to derive any evidence of how increased learning was facilitated. Another study conducted by Welsh et. al (1993) found that designers of hypermedia may have to make tradeoffs between systems that promote exploration and those that have high levels of usability. The labeled link treatment resulted in less exploration of the database than the unlabeled link treatment. Thus, if a hypermedia designer seeks to promote unguided exploration of a database unlabeled links are preferable; if targeted exploration is the goal, labeled links should be employed.

If a designer seeks to promote exploration they will want to place a greater emphasis on the facilitation of browsing: knowledge exploration in which the system provides contexts for the user (Marchionini and Scneiderman, 1988) rather than searching (seeking a particular piece of information). According to Gall and Hannafin (1994) browsing requires effective metacognitive awareness and control by the learner. They believe browsing has been overlooked in educational settings. They emphasize that much of what is learned is acquired incidently and browsing can facilitate such learning.

Jones and Okey (1995) have put forth guidelines for the development of browsing systems, many of which are also applicable to hypermedia in a general sense. They emphasize selectable areas such as buttons or hot words that allow the user to access information in a user determined order via topic indexes. They also believe maps that allow users to find where they are and to jump to other information of interest are key elements of a browsing system. They correctly point out that traditional maps may not be feasible due to the size of many databases. Instead, they suggest that maps may have to be represented in the form of text based indexes, outlines or tables of contents. Two other suggestions they make regard providing the user with feedback when significant time delays are required in order to access information and providing the user with visual feedback indicating that their choices have been made and registered by the system.

Excessive and/or poorly designed navigation systems may lead to disorientation and cognitive overload. According to Conklin (1987) disorientation is two fold, the relatively simple problem of finding out where you are in the system and the more complex problem of discovering how to get somewhere else in the system that you know or think you know exists. Tripp and Roby (1990) believe disorientation can lead to cognitive overload. They theorize that if a student's mental resources are consumed by navigational tasks there won't be as many resources available for learning and achievement may suffer.

Disorientation may be minimized by the inclusion of an option that provides access to the front/top page from anyplace in the system, tables of contents, indexes, the use of familiar metaphors such as books and graphical map-like organizers (Conklin 1987). Kinzie (1991) also recommended that designers try to devise a system where the users were never more than two or three steps away from desired information. She also suggested providing a locator icon on each page that if selected, would lead the user to a graphical representation of their location within the program.

Park and Hannafin (1993) theorized that cognitive overload can be avoided and learning can be maximized if hypermedia system features are self-evident, logically organized, easily accessible and readily deployed. The overall goal should be to come up with a screen design and procedural conventions that require minimal cognitive resources. This will enable the learner to use the highest possible amount of cognitive resources for learning rather than navigation.

While most of the literature supports the utilization of a spatial metaphor as a tool to prevent disorientation Stanton (1990) conducted a study that led him to question the use of the spatial metaphor. His findings led him to believe that a conceptual metaphor might be superior. His study found that high achievers who were provided with a spatial map preformed poorer than those who were not provided with a spatial map. No significant difference was found with other ability groups. He theorized that the presence of a spatial map might interfere with the development of a cognitive map because participants were focused on the spatial map rather than assimilating information from the screen. He also believes that the creation of a spatial map that presents all possible associations and yet permits ease of use is futile. Hammond and Allison (1989) concur and suggest that conceptual orientation is more appropriate than spatial orientation because a learner's goal usually is to become orientated conceptually rather than spatially.

Other interesting research findings related to hypermedia navigation include the finding that there was no significant differences in readability based on link density (Welsh et. al 1993). Also, Schroeder (1994) concluded that graphical browsers resulted in higher achievement as compared to embedded hot words. Gay, Trumbull and Mazur (1991) found that the browse mode and the online helper mode were superior for the purpose of information location as compared to an index. Finally, Leader and Klein (1994) completed a study that showed field-independent subjects achieved better than field-dependant subjects in both the index and map search modes but not in the browser or all tools modes.

THE IMPACT OF HYPERMEDIA DESIGN ON EXPLORATION/LEARNING

Hypermedia and hypermedia design impact exploration and learning in a variety of ways, even though hypermedia was developed for information storage and retrieval. Hypermedia provides the learner with a large amount of control which tends to help motivation, but may hurt learning (Steinburg 1989). Hypermedia also fosters discovery, incidental and unstructured learning. Gall and Hannifin (1994) feel that traditional computer-based instruction stresses defined outcomes, efficiency and convergent thinking. Hypermedia on the other hand, stresses global and unspecified outcomes, exploration, and divergent learning.

Heller (1990) believes hypermedia shares many characteristics with discovery and incidental learning. Hypermedia and discovery learning both provide the learner with a great deal of control. Both hypermedia and incidental learning include objectives, scope and intent that are not fully known to the learner. Unfortunately, one of hypermedia's greatest strengths: the ability to facilitate open-ended learning, has lost favor with a society that wants well defined convergent learning to take place in schools.

Hypermedia facilitates several pedagogically sound design elements. Jonassen (1988) theorizes that hypermedia allows for text, graphics and sound that reinforce one another. It also focuses on how things are related rather than isolated facts. Park and Hannafin (1993) believe that key pedagogical aspects of hypermedia are its ability to provide multiple complementary stimuli and to build on prior knowledge through the layering of information. They point out that it provides ample opportunities for shifts in attention which can result in increased learning.

Instructional design and Gagne's nine events of learning are directly related to hypermedia design. Both instructional design and hypermedia design emphasize task analysis and the creation of a learning hierarchy. Jonassen (1991) considers instructional design and hypermedia to be theoretically and operationally consistent in that they both share underpinnings in systems and cognitive theory. However, he does point out that hypermedia generally provides an open information system while instructional design often results in a closed system of interaction. He also notes that hypermedia provides designers with a tool that allows them to go beyond objectivism and determinism due to the fact that user defined browsing strategies and collaborative authorship lead to a system where the structure and content respond to environmental input and feedback.

Overbaugh (1994) related instructional design and Gagne's nine events of learning to hypermedia design. I will attempt to summarize some of his conclusions. Learner control and cuing are two important aspects of instructional design. With regards to learner control he feels that hypermedia presents an ideal opportunity for learners to direct their own learning. Screen design and text format provide unlimited opportunities for cuing. Screen based cues might include high-lighting, color, arrows, underlining and shading. Text-based cues might include elaboration on associations between concepts and examples.

Gagne's first event of learning: gaining attention, is related to the creation of an effective hypermedia title screen. Theory related to his fourth stage of learning: presenting stimuli with distinctive features, includes much that is related to screen design. Besides paying attention to text and graphics it is especially important to consider the manner in which to focus the student's attention on the most important points. Overbaugh believes the screen should be keep uncluttered and that color and text formatting are two of the most effective ways to draw attention to important points.

Gagne's fifth stage of learning: providing learning guidance, refers to a method of instruction that incorporates a steady progression from simple to complex. Overbaugh refers to this type of sequence as an elaboration sequence. Hypermedia provides several elaboration possibilities. Helpful, but none essential information may be accessed via a link. Successively more complex subject matter may be accessed via a series of links and maps that visualize interrelationships can provide guidance for complex subject matter.

Effective hypermedia design also incorporates psychological theory. According to (Marchionini 1991) the information processing model of cognition provides a model for interface design. The model establishes that humans can remember between five and seven chunks of information at one time and must have their attention refreshed frequently. Additionally, recalling requires more cognitive effort than recognizing. Interfaces consistent with this model might include menus and reversibility. Menus are preferable to command languages because the user only has to recognize rather than remember an appropriate option. Besides promoting exploration, reversibility frees cognitive resources that might have been used to remember how to get back to where one has already been.

The interface is the basis for the mental model users develop for a hypermedia system (Marchionini, 1991). Hypermedia designers should strive to develop effective mental models for the systems they create. This can be accomplished through the creation of a metaphor that connects existing knowledge and system function. Hypermedia interfaces should compensate for human cognitive limitations, be transparent, and be consistent.

DESIGN OF A PARTICULAR HYPERMEDIA APPLICATION: WORLD WIDE WEB (WWW) HOMEPAGES

A WWW homepage is the entry point and interface for a local web site. It includes links, facilitated via hypertext transfer protocol (HTTP), to local or remote files (nodes). A WWW homepage may also be referred to as a document on the web that makes use of hypermedia links. The computer the document is stored on is called the server. The address of a particular WWW homepage or any of the nodes within it is called the uniform resource locator (URL).

Presently there are almost seventy million homepages that can be accessed via Lycos, a WWW search engine. It is estimated that the number of homepages is growing at a rate of fifteen percent a month. The mass and growth rate of materials accessed via WWW homepages make the WWW homepage a significant source of information. Additionally, WWW browsers like Netscape make it very easy to create hypermedia documents which can be combined with external hypermedia documents accessed via the WWW. Properly designed WWW homepages can provide a rich source of databases and/or instructional material.

There hasn't been a lot of research on WWW homepage design. But, the previous sections of this paper show that much of what has been learned about hypermedia, computer assisted instruction, graphical user interfaces and database creation is directly applicable to WWW homepage design. Conklin (1987) believes that an easily modulized large knowledge base that is commonly used for reference or browsed frequently is well suited for the hypermedia format. WWW homepages certainly fulfill all of these criteria. Van Brakel, Roeloffze and Van Heerden (1995) state that the physical appearance of a well designed homepage is similar to that of a well design graphical user interface. They believe that in designing a WWW homepage file basic hypermedia design principles can be applied.

A particular element of good design shared by hypermedia and WWW homepages is the need to field test early and often. As is the case with hypermedia design, WWW homepage design that is purely hierarchical in nature is not nearly as complex as a design with a large number of complex links that facilitate full nonlinear/associative searching. Also, WWW homepage construction requires the same type of preplanning as hypermedia design including the determination of purpose, scope and audience.

There are several additional design aspects unique to WWW homepages. Shotsberger (1996) thinks one should avoid large logos and unnecessarily large visuals due to the fact that they impose relatively large memory requirements and slow down the transfer of information. Van Brake and Van Heberden (1995) feel that important aspects of WWW homepage design include a feedback mechanism (possibly a fill in form) that allow users to comment on the design or content of a system, date of creation and date of last update designations and a what's been added recently section.

Falcingo and Green (1995) look at WWW homepage design from a librarian's perspective. They emphasize that the homepages should be organized by subject area and connections to outside sources should be based on clearly defined collection development policies. They also emphasize the need to get to the root level of a source and to limit each homepage to a listing of items that can be read on a single screen. A final unique aspect of WWW homepage design is the heavy maintenance requirements that accompany most homepages. WWW homepage design is a continual process. One needs to continually eliminate connections that no longer exist, monitor and react to user feedback and add newly created sights.

APPLYING HYPERMEDIA RESEARCH AND THEORY TO WORLD WIDE WEB (WWW) HOMEPAGE DESIGN

Based on hypermedia research referred to in this paper a number of recommendations for the design of a WWW homepage can be made:

*Screen design should be as consistent as possible.

*Text should be at least 12 point and preferably at least 14 point.

*A WWW homepage's layering capabilities should be utilized in order to break large portions of text into smaller internally consistent segments. Whenever possible, strive to include only the amount of information or links that can be read from a single page, but do not hesitate to include as many links as you need to within a particular page.

*Medium density screens are preferable to high density screens or low density screens; moderately complex screens are preferable to simple screens or complex screens.

*Concentrate items at the optical center of the screen (the upper middle section of the screen).

*Mix high and low color intensity or high and low color brightness to focus user attention.

*If graphics and text are to be mixed use wrap-around text rather than run-around text.

*Develop structure through the use of headings and bold type, incorporate well balanced white space around the exterior of the screen; avoid unnecessary graphics and large unbalanced areas of white space.

*Attempt to map the structure of the type of information the WWW homepage is providing access to.

*Each node/destination within a WWW homepage should be developed so that it can stand alone. Information may have to be repeated in more than one successive node so the user won't have to go back to a previous node in order to figure out the meaning of the present node.

*Attempt to incorporate a metaphor that is obvious and applicable to the information being presented by the WWW homepage.

*Provide users with visual clues that let them know their choice has been made and registered by the system and that indicate progression towards the retrieval of an item.

*When possible, include graphic organizers, when graphic organizers are not possible due to the size of database, include text based organizers such as indexes and outlines.

*Consider the inclusion of various link types including comparative, causal, sequential, associative, exemplary and componential.

*Employ labeled links to facilitate targeted searching and unlabeled links to promote browsing and incidental learning.

*When designing complex WWW homepages, consider the utilization of multiple complementary stimuli.

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